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Growth, yield and quality attributes of guava as influenced by canopy management practices: A review

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Abstract

Guava (*Psidium guajava* L.) is major tropical fruit crop grown throughout the tropical and sub-tropical regions. Guava is native from tropical America; its cultivation has spread to all tropical countries, with India being particularly important. It is a resilient, prolific bearer, and very profitable fruit crop that may be produced successfully in a variety of soil and climatic conditions. As a result, canopy management aids in achieving high quality and productivity. Now a days, there is a global trend in fruit-producing countries to accommodate the largest number of fruit plants possible by employing canopy management and pruning procedures to regulate tree growth and structure, so limiting tree size while yet ensuring high fruit production of desired quality. Pruning not only helps to encourage new shoots after the harvest but has also been adapted for rejuvenation of orchards along with crop regulation. Canopy management includes training and pruning, rootstock and scions, high density planting system and application of plant growth regulators. Guava bears flowers on current season's growth. Therefore, a light annual pruning is considered to be essential to boost up new vegetative shoot emergence. The length of flowering shoots tended to decrease with delay in time of pruning but increased with the increasing severity of pruning irrespective of season. An increase in shoot length due to severity of pruning might be due to elimination of growing points which in turn encouraged the length of remaining shoots. Pruning by heading back encourages new, long, whip-like shoots growth with sparse flowering compared with cutting at fork. Plant architecture management included, training and pruning of guava trees has been found to improve yield and fruit quality. The trees should be kept open for better penetration of sunlight leading to more number of shoot and higher yield.

Keywords: Fruit, canopy, pruning, productivity, quality, season, yield

Introduction

Guava (*Psidium guajava* L.) belong to the Myrtaceae family. The guava fruit has grown in popularity as a result of its excellent nutritional value, attractive aroma, rich flavour, and affordable market availability (Bal and Dhaliwal, 2003) [8]. Guava is a good source of Ascorbic acid (Vitamin C) (250-300 mg/100 g of pulp), contains carotenoids and polyphenols which are the major classes of dietary antioxidant pigments among plant foods (Hassimotto *et al.*, 2005; Jimenez-Escrig *et al.*, 2001) [35, 39]. Due to its astringent properties, mature guava fruits, leaves, roots and bark are used in local medicines to treat gastroenteritis, high blood pressure, asthma, diarrhoea and obesity (Joseph and Priya, 2011) [40]. Besides its high nutritive value, it yielded a heavy crop every year and gave good economics returns involving very little inputs. In general, guava bears in three season's namely rainy, winter and spring seasons in a year. Fruits of rainy season crop are insipid in taste, poor in quality, less nutritive value and attacked of insect pests and diseases. On the other hand fruits of winter season crop are superior in quality, comparatively free from diseases and insect pests and fetch higher prices in the market (Rathore and Singh, 1976) [69].

Guava has a higher proportion of 'shade' to 'sun' leaves and their leaves are found photo synthetically inactive under deeper shade and act as unproductive sink Therefore, vegetative growth, fruit yield and quality are functions of light interception and translocation of light energy into chemical energy. Quality fruit is function of absorption of light and light is directly proportional to the yield of fruit trees (Jackson, 1980; Palmer, 1989) [37, 63]. Light interception was more in guava trees planted, at wider spacing and decrease significantly with the depth of the canopies irrespective of the planting densities. It was observed that fruit yield and quality of guava fruits decreased with poor light interception at higher planting densities.

According to area and production guava is the fifth most important fruit after Mango, Banana, Citrus, and Apple in India. The area under guava in India is about 0.27 million hectares, producing 4.10 million tones, Productivity of 13.7 million tones/hectare. In India, largest area and highest production under guava fruit is Uttar Pradesh and highest Productivity is in Andhra Pradesh (NHB data, 2018-019). The foremost reasons for low productivity are low planting density, no canopy and floor management and no crop regulation. Canopy management strategies are responsible for 30-40% increased output. Despite the fact that it reduces tree size and enhances fruit quality, shoot trimming has recently been proven to be effective in regulating guava crop production. As a result, the number of trees per unit area can be increased. Moreover, observations have shown that after 8-10 years of age, guava trees show considerable decline in yield with sub-optimal fruit quality owing to vigorous vegetative growth and frequent intermingling of the branches particularly in the lower half of the tree leading to unfruitfulness, as fruitful buds become blind. Such unproductive trees can be made to bear profitable crop for more years by judicious canopy management. Canopy management is resorted as a tool not only to control size but also maximize yields. Pruning has been used for orchard renewal as well as crop regulation, in addition to encouraging new shoots following harvest. Pruning is an ancient cultural method used in temperate and sub-tropical fruit crops to balance vegetative and reproductive growth. The flowers and fruits of the guava are produced on the current season's growth. A light annual pruning is considered necessary to encourage new shoots after the harvest. A better understanding of the effect of pruning is the need of an hour. Guava pruning has received little attention, yet given its economic relevance, it is justified. Pruning increased the yield of guava cv. Sardar, according to Lal (1983)^[49]. Salah and El (2005)^[72] similarly found that severe and moderate pruning resulted in the most guava bud emergence. Moreover, Serrano *et al.* (2008)^[76] reported that the light pruning increased the number of productive branches and number of fruits per branch of guava cv. Paluma.

Canopy management practices in Guava

Canopy management is the process of adjusting the tree canopy to increase the production of high-quality fruits. An optimal training method focuses on the arrangement of plant parts, in particular, in order to build a superior plant architecture that maximizes the use of sunlight and increases output. Fruit tree canopies must be managed to achieve the best balance of vegetative development and fruit output. Managing a canopy will aid in the development of a sturdy tree capable of supporting big crop loads, as well as increased fruit yield and improved frost resistance. Because guava trees respond effectively to canopy change in terms of vegetative and reproductive growth trimming the canopy and using particular growth regulators in high density orchards may be approaches to improve production efficiency. Guava has a higher proportion of 'shade' to 'sun' leaves and their leaves are found photo synthetically inactive under deeper shade and act as unproductive sink. As a result, light interception and transfer of light energy into chemical energy are functions of vegetative development, fruit output, and quality. Fruit quality is a function of light absorption, and light is directly related to fruit tree productivity (Jackson, 1980; Palmer, 1989)^[37, 63].

Principles of Canopy Management

The basic principles of canopy management are as described by Shikhamany (2001)^[77].

1. Maximum utilization of light.
2. Avoidance of build-up of micro-climate congenial for the disease and pest.
3. Convenience in carrying out the cultural operations.
4. Maximizing the productivity and quality.
5. Economy in obtaining the required canopy architecture.

Methods of Canopy Management

The methods of canopy management are given by Salah and El (2005)^[72].

1. Training and Pruning
2. Use of growth regulating rootstock and scion
3. High density planting system
4. Use of plant growth regulator

Effect of canopy management on vegetative parameters

Because of the orientation of sunlight, observed that canopy spreading in an east-west direction was better than in a north-south direction. Lian *et al.* (2019)^[50] observed the effects of pruning months (mid-April, mid-May and mid-June) and pruning severity (pruning of 25%, 50% and 75% of shoot length from tip) on growth and yield of guava cv. L- 49 planted at a spacing of 6 m x 6 m at Fruit Research Farm, Department of Fruit Science, College of Horticulture, Pasig hat, Arunachal Pradesh during April to December 2017, with an aim to optimize the time of pruning and intensity of pruning for harvesting of winter guava crop. Pruning in mid-April was found to be the best for increasing plant growth characteristics such plant height, collar girth, E-W and N-S canopy spread, length of shoot, fruit set, and number of fruits/plant, but mid-May pruning produced the highest maximum fruit output (kg/tree). When the degree of pruning was compared to the length of the shoots trimmed, different reactions were noticed. According to Thakre *et al.*, high density management and crop regulation are two important aspects of guava (*Psidium guajava* L.) cultivation (2016). In order to determine the most cost-effective method of managing high density planting and crop regulation, the current study was conducted on 6-year-old guava trees of cv. Pant Prabhat planted in a double-hedge row system in 2009-10 and 2010-11. Seven different forms of pruning [FBT: flower bud thinning by hand, FBTT: flower bud thinning by hand followed by removal of terminal one leaf pair, RLFO: removal of leaves and flower buds by hand, retaining one leaf pair at the top, RLF: removal of all leaves and flowers by hand, OLPS: one leaf pair shoot pruning, FSP: full shoot pruning, OLPF: one leaf pair pruning of fruited shoots only] were studied along with control (C). Minimum annual increase in tree volume (6.764 m³) was recorded with the treatment OLPF, which was 2.31 times less than the control (15.682 m³). A split-pot design was utilized to assign three pruning periods (mid-April, early May, and mid-May) and four pruning levels to each treatment, with three replications in each (0-, 10-, 20-, and 30-cm tip removal).

Effect on shoot numbers

In terms of growth, the 90 cm pruning intensity produced the longest shoots (46.22 cm), the most internodes (16.20), and the most shoots (9.88) in the last harvest (Choudhary and Dhakare 2018)^[43]. Pruning from April to June resulted in an

increase in the number of shoots Serrano and his colleagues (2008) reported that the light pruning increased the number of productive branches of guava cv. Paluma. Mohammed *et al.* (2006) [60] reported that the 30 and 60 cm pruning level generally found to increase the number of shoots. According to Bhagawati *et al.* (2015) [9], gentle pruning increased the number of shoots the most. According to Sarker and Ghose (2006) [74], bending shoots increased the number of shoot lets per branch. According to Dubey *et al.* (2001) [27], the highest number of branches that appeared following pruning (lateral shoots) were obtained with pruning intensities of 100 and 25%. Ethephon (600 ppm) produced the highest number of new shoots in both seasons Pratibha and Shant Lal (2012) [65] reported that one leaf pair shoot pruning significantly influenced the emergence of new shoot. Guerra and Bautista (1999) [31] reported that the guava trees height and number of Shoots were greater in Mara 4 and Mara 6 trees than in Mara 8 trees after the first pruning. (Sawant *et al.*; 2018) [62] Observed maximum no. of shoots per plant, minimum days required for flowering, minimum days required from pruning to fruit set, days from fruit set to harvesting, maximum no. of fruits per tree and maximum yield were recorded in 50%, 33%, and 25% heading back of tertiary branches.

Effect on linear and radial growth of shoot

The highest increase in new shoot let length was achieved by pruning at 45 cm length in May. (Meena *et al.*, 2016) [55]. Pruning guava plants promoted vegetative growth and, as a result, increased shoot length (Bisla *et al.*, 1988) [10]. The maximum shoot length in highly trimmed guava plants was measured by Bajpai *et al.* (1973) [27]. (100 cm). Agnihotri *et al.* (2013) [2] found that foliar spraying with 60 ppm 2, 4-D increased shoot length. The usage of potassium sulphate (1%) significantly improved the branch length of the guava tree (Manivannan *et al.*, 2015) [54]. According to Bhagawati *et al.* (2015) [9], the earliest emergence of buds and cumulative lengths of new shoots are due to vigorous pruning. According to Chandra *et al.*, regenerated guava trees were the most successful in stimulating the growth of new shoots (2012) [19]. According to Sarker and Ghose, bending shoots resulted in increased shoot length (2006) [74]. Reported that bending the branches was most effective in controlling vegetative shoot growth. Dubey *et al.* (2001) [27] studied that the greatest length of shoots emerged after pruning (lateral shoots) with 100 and 25% pruning intensities.

The maximum gross return was likewise attained when the shoots were pruned three times a year to 50 percent of their original length (Mehta *et al.*, 2012) [56]. The cost-benefit ratio of one leaf pair pruning of fruited shoots alone (OLPF) was similarly found to be beneficial when compared to other treatments, with a cost-benefit ratio of 1:2.96. This treatment also yielded the maximum return in both the rainy and winter seasons.

Days to sprouting of new shoots

Maji *et al.*, (2015) [53] found that 60 cm trimming resulted in early sprouting and flowering. Mohammed *et al.* also made a similar observation (2006). Shoot lets appear earlier, and the shoots bend (Sarker and Ghose, 2006) [74]. The production of laterals was 12.8 days earlier in guava trees that had their leaders pruned by 4 to 5 inches than in plants that had not been pruned (Aravindakshan, 1963) [4]. Based on the data, it

can be stated that only one leaf pair pruning of fruited shoots is appropriate for profitable high density management and guava production regulation in a farmer-friendly manner The experiment found that pruning at 45 cm shoot length in May resulted in the biggest increase in new shoot length (1.83 cm) at 15 days after pruning (DAP), followed by 30 cm pruning in April, and the lowest (0.31 cm) in the control, which followed a similar trend until 120 DAP (Meena *et al.* 2016) [55].

Flower drop

Guava cv. Sardar trees were cut at 45cm level in the first week of March to prevent bloom decrease (Brar *et al.*, 2007) [16]. Sarker and Ghose arrived at the same conclusion (2006) [74]. Flower drop and fruit set percentages were at their maximum with 100 percent pruning intensity (Dubey *et al.*, 2001) [27]. Similar results were achieved by Singh *et al.* (1996) and Rajput *et al.* (1977) [68]. They found that spraying NAA (200) on guava cv. Allahabad Safeda resulted in less blossom or fruit drop. Fruit drop was reduced when 60 ppm 2, 4-D was sprayed on the leaves (Agnihotri *et al.*, 2013) [2]. However, in the winter season crop, treatment P4 (TNFS+OLP) had the highest percent fruit set, whereas treatment P7 had the lowest (TNFS).

Effect of canopy management on floral and yield parameters

Guava trees bloom twice a year, in April-May and August-September, with fruits ripening throughout the rainy and cold seasons (Gupta and Nijjar, 1978) [32]. Fresh growth develops in the leaf axil quickly after the break of winter stress, and floral buds form. Floral buds appear shortly after the first pair of mature leaves, although there is no link between the appearance of the leaves and flower production (Menzel and Paxton, 1986) [57]. Flowers appear solitary or in cymoses of two or three at the leaf axils of the current season's growth (Braganza, 1990) [13].

Number of flowers

Bajpai *et al.* (1973) [27] and reported that pruning adversely affected flower production in guava and the maximum number of flowers were obtained in lightly pruned trees in comparison to unpruned trees of guava during rainy season. The amount of guava flowers varies based on the season, variety, and other cultural treatments such as PGR, among other things. To obtain maximal blooming, Chandra and Govind (1994) [20] utilized urea (25 percent) and ethrel (2000 ppm). Spraying of ethrel (1 ml/liter) caused greater ethylene-forming enzyme activity in leaves leading to maximum number of flowers and fruits (Castelan- Estrada and Becerril Roman, 1994) [18]. According to Agnihotri *et al.* (2013) [2], foliar spraying with 60 ppm 2, 4-D increased the quantity of blooms. In the summer season flush, discovered that the 30th May pruning resulted in the lowest number of flowers (0.54) and fruit set per shoot (0.06), but the maximum number of flowers (5.05) and fruit set per shoot (3.33) in the kharif season flush. The results showed that pruning treatment accelerated the development of flowers and increased the number of generative shoots, the number of flowers per tree, and the amount of fruit collected, according to Widyastuti *et al.* (2019) [75]. The rate of stomatal conduction, as well as the quantity of stomata, support the increased blooming response caused by trimming.

Fruit set

Guava has a high natural fruit setting rate (80-86%), however only 34-36 per cent of the fruits mature (Mitra and Bose, 1990) [59]. Two foliar sprays of CCC (50 ppm) and PCPA (50 ppm) (one before flowering and one after fruit set) significantly increased fruit set in Sardar guava (Brahmachari *et al.*, 1996) [14]. Significant increase in initial fruit set was found with moderate pruning and application of 4% potassium nitrate. Fruit set was reduced by eugelol and ethephon at higher concentration (Curry and Williams, 1989) [23]. Choudhary *et al.* (1997) [22] observed that NAA (100 ppm) resulted in maximum percentage of fruit set. Significant increase in initial fruit set was found with moderate pruning and application of 4% potassium nitrate. Fruit set was reduced by eugelol and ethephon at higher concentration (Curry and Williams, 1989) [23]. Choudhary *et al.* (1997) [22] observed that NAA (100 ppm) resulted in maximum percentage of fruit set. Boora *et al.* (2016) [12] reported that, the terminal portion of guava shoots should be pruned between 20th to 30th April. Application of the necessary fertilizer dose in June promotes vegetative development in July-August, allowing for optimal flowering in August-September for the winter season crop. It is critical to minimize fruit set during the rainy season and then boost fruit set during the winter season to regulate the guava crop.

Fruit number

The quantity of fruits per shoot reduces in the rainy season as chemical concentrations rise, but increases in the winter season. According to Kumar and Hoda, spraying guava plants with 125 ppm NAA at full bloom stage (April-May) during the wet season resulted in no fruiting (1977) [47]. Singh also reported similar findings (1986). At 60 and 30 cm pruning levels, there was a significant increase in the number of fruits and the weight of the fruits (Mohammed *et al.*, 2006) [60]. According to Brar *et al.* (2007) [16], the plants grown at a height of 15 cm produced the most fruits and yield. With apical 10 cm of trimming branches in May, the number of fruits per tree increased (Sahar and Abdel-Hameed, 2014) [70]. According to Sarker and Ghose (2006) [74], bending shoots increased the number of fruits per shoot let. According to Kumari *et al.* (2003) [48], trees trained into a vase shape produced the longest shoots (cm) with the most fruits. One leaf pair shoot pruning enhanced the quantity of fruits per tree, yield (kg/tree), and fruit quality, according to Pratibha and Shant Lal (2012) [65]. In the third week of June, 2012, Lakpathi *et al.* pruned guava cv. Allahabad Safeda under high density planting with three pruning intensities: leaving 10 cm, 20 cm, and 30 cm from the base of the shoot and maintaining 30, 40, and 50 fruits per tree. reported in winter season crop, maximum number of fruits per plant (483) and fruit yield per plant (73.72 kg) and per hectare (20.37 t) was recorded with 30th May pruning.

Fruit weight

At 45 cm, Brar *et al.* (2007) [16] showed an increase in fruit weight. Bhagawati *et al.* (2015) [9] found that pruning intensities increased fruit output. The regenerated guava tree was shown to be the most effective for increasing fruit weight and yield, according to Chandra *et al.* (2012) [19]. Fruit weight and volume were best in May and June with apical 20 cm of new trimmed shoots. Fruit thinning increased the weight of

individual fruits. Fruit retention, volume, and weight were all improved by severe trimming (Sheikh and Hulamani, 1994). In terms of individual fruit weight and per plant fruit output, the effect of thinning exhibited a similar trend (Biswas *et al.*, 1989) [11]. Fruit weight was observed to rise when PBZ 500 ppm was used, especially during the wet season (Brar *et al.*, 2012) [17]. Curry and Williams (1989) [23] discovered that at greater concentrations of ethephon, average fruit weight and length were significantly reduced. Raghbir *et al.* (1992) [67] studied that the highest fruit weight was obtained with 600 ppm NAA. Similar results were obtained by Kher *et al.* (2005) [46]. In winter season fruits, plants sprayed with PBZ 1000 ppm exhibited highest fruit weight (Brar, 2012) [17]. In both seasons, the amount of trimming and the timing of pruning enhanced the size and weight of the fruits (Adhikari and Kandel, 2015) [15]. The development of vegetative buds, maximum fruit diameter at harvest, average fruit weight, and fruit yield have all improved with ten centimeter (10 cm) pruning intensity (Lakpathi and Rajkumar) (2018) [33].

Fruit yield

According to Dutta (2004) [28], foliar spraying of K greatly increased the production of Sardar guava. Singh *et al.* also showed an improvement in guava yield by employing potassium nitrate (1992). Bagchi *et al.* (2008) [6] investigated biochemical changes in the leaf and bark of guava during offseason flowering and found that varied bending and pruning treatments resulted in enhanced overall fruit output. Shoot pruning can assist you manage your tree's size and fruit production. Plants with pruning treatments produce more fruit. Similar observations were made by others as well (Lopez *et al.*, 1982; Quizada *et al.*, 1999; and Maji *et al.*, 2015) [51, 66, 53]. Bhagawati *et al.* (2015) [9] reported that the fruit yield, size and weight were found to increase with pruning intensities. Under high-density planting, Chandra and Govind (1995) [21] claimed that 25% pruning in February might regulate fruit yield without affecting fruit quality. For the winter crop, Mishra and Pathak (1998) [58] trimmed guava plants cv. L-49 (Sardar) by 25, 50, or 75 percent at monthly intervals between March and June, with 50% pruning in May producing the best fruit yield. The most successful management for reducing yield in the rainy season and increasing yield and quality in the winter season was to prune guava plants at a 20 cm pruning level in early May. (Adhikari and Kandel, 2015) [15]. According to Katiyar *et al.* (2009) [44], the maximum yield was found in urea 2% + NAA 100 ppm. Manivannan *et al.* (2015) [54] investigated that application of potassium sulphate (1%) significantly enhanced the yield parameters *viz.*, fruit length, number of fruits, fruit weight and yield per tree. Saini *et al.* (2016) [71] observed that all the treatments were effective in increasing the growth characters, however, heading back at the level of 200 cm and two pinchings were found most effective in increasing the growth characters *i.e.* number of sprouts per shoot, flowering intensity, fruit setting, number of fruits/plant and yield over control and other treatments. Harshitha *et al.* (2019) [34] In pruning at 75 cm and PBZ at 500 ppm, the interaction effect of pruning and chemical spraying on number of fruits per shoot (3.39), fruits per plant (343.97), and maximum yield of fruits per plant (49.14 kg) was shown to be significant (P2S1). When trimming at 75 cm and GA3 at 50 ppm, the greatest fruit weight (127.67 g) was recorded (P1S5).

Fruit Size

During the rainy season, pruning treatments (10cm and 20cm) on guava cv. Allahabad Safeda resulted in the largest fruit size. According to Brar *et al.* (2007) [16], pruning at 45 cm increased fruit weight. Trees that received 0% defoliation and 50% de blossoming had larger fruit diameters and sizes (Khan *et al.*, 2011) [45]. Fruit size, weight, and organoleptic value all improved as well. Fruit thinning, according to, enhanced the size and weight of individual fruits. PBZ 500 ppm was observed to improve fruit size and weight, especially during the wet season, whereas ethephon 500 ppm-treated plants produced the best-quality fruits (Brar *et al.*, 2012). Applying 2% urea + 0.4 percent ZnSO₄ + 250 ppm ethrel (ethephon) + 10 ppm NAA resulted in the largest fruits (Pandey *et al.*, 1988). In all seasons, increasing pruning levels and delayed pruning enhanced fruit size and weight (Adhikari and Kandel, 2015) [15]. As the degree of pruning grew, so did the size, weight, pulp percentage, and seed percentage of the fruit. Maximum fruit polar diameter (9.02 cm) and equatorial diameter (9.28 cm), maximum fruit weight (305.21 g), and highest pulp content (54.34 percent) were discovered after 90 cm of pruning intensity. In 90 cm, a significant minimum percentage of seed (7.68%) was recorded. Choudhary and Dhakare (Choudhary and Dhakare, 2018) [43]

Effect of canopy management on quality attributes

Total soluble solids

During the wet season, found that pruning treatments (10cm and 20cm) on guava cv. Allahabad Safeda yielded increased TSS and Vitamin C. Bhagawati *et al.* obtained similar results (2015) [9]. TSS content was shown to be most effective in the rejuvenated guava tree from 1.5 to 2.0 meters above ground level (Chandra *et al.*, 2012) [19]. In May and June, TSS values were highest with apical 10 and 20 cm of fresh trimmed shoots. TSS was shown to be higher in the larger fruits acquired after thinning (Biswas *et al.*, 1989) [11]. Sindhajli rootstock had higher total soluble solids content, according to Jat (2003) [38]. Furthermore, the TSS content of fruits picked during the winter season was higher than that of fruits harvested during the summer season. With urea (10, 15, and 20%), higher TSS contents were achieved (Raghubir *et al.*, 1992) [67]. The use of 60ppm 2, 4-D enhanced a number of quality metrics, including total sugars, reducing sugar, non-reducing sugar, and TSS (Agnihotri *et al.*, 2013) [2]. At the 10 cm level of pruning, noted fruit quality (chemical characteristics).

Vitamin C

Studied the effect of rootstock on vitamin C concentration and found that *P. cujavallis* had increased vitamin C content. Sardar guava performed best on Portugal rootstock in terms of TSS, although Chittidar had the highest vitamin C content, according to Gill and Chahil (2013) [29]. Fruits derived from ethephon 1000 ppm treated plants during the rainy season and ethephon 500 ppm treated plants during the winter season had the highest vitamin C content (Brar *et al.*, 2012) [17]. During the wet season, Badge and Kandalkar (1983) [5] found an increase in ascorbic acid content in guava with 80 ppm NAA. Singh (2006) [60] discovered that fruits of the rainy season guava cv. had a greater vitamin C content. Sardar got it from PBZ-sprayed plants (500 ppm). Fruit quality analysis revealed that pruning in May at 45 cm from the shoot tip yielded superior quality fruits with greater vitamin C levels of 235.17

mg/100g (Meena *et al.*) (2017) [42].

Total sugars

According to Tahir and Hamid (2002), fruit thinning increased the quality of the winter harvest, which produced more sugars. According to Singh *et al.* (1976), the fruit production of Allahabad Safeda was higher on *P. cattleianum* rootstock, but the TSS, total, and reducing sugar levels were highest on *P. cujavallis*. Manivannan *et al.* (2015) [56] found that adding 1% potassium sulphate to the fruit length, number of fruits, fruit weight, yield per tree, and quality metrics like TSS, acidity, total sugars, reducing sugars, and ascorbic acid significantly improved yield parameters. Various quality parameters namely total sugars, reducing sugar, non-reducing sugar were also improved with application of 60ppm 2, 4-D (Agnihotri *et al.*, 2013) [2]. Rajput *et al.* (1977) [68] studied that total sugars and reducing sugars were not significantly affected with 60 and 80 ppm NAA in guava during rainy season. Wider spacing of guava fruits resulted in greater TSS, according to, Singh and Bal (2002), and Bal and Dhaliwal (2003) [8]. In May and June, apical 10 cm of pruning shoots improved fruit set % and total sugars (Ali and Abdel-Hameed, 2014) [3].

Acidity

Brahmachari *et al.* (1995) [15] found that spraying 50ppm NAA in guava during the wet season lowered acidity marginally. Sprayed ethephon in May and found that a higher dose of ethephon considerably lowered acidity. During the wet season, spraying guava with 40 and 80 ppm NAA reduced the acidity slightly (Rajput *et al.*, 1977) [68]. In the rainy season, Badge and Kandalkar (1983) [5] obtained similar results with 60 and 80 ppm NAA, and Brahmachari *et al.* (1995) [15] with 50 ppm NAA. In the wet (0.26 percent) and winter seasons, Singh (1986) found that NAA (100 ppm) lowered the acidity of fruits (0.39 percent). Wider spacing along with pruning gave higher fruit weight, size, TSS, acidity, ascorbic acid and TSS: acid ratio of guava fruits than closer spacing (Pratibha and Lal, 2012) [65].

Conclusion

After a few years of growth, untrained or unpruned guava trees become enormous and unmanageable. The bearing area of the plant is diminished, and the interior of the plant is barren of fruiting. By removing crowded and criss-cross branches, trees are pruned to maximise the output of high-quality fruits. Pruning begins at an early stage of plant growth to develop single trunk trees with well-spaced scaffold branches to form the frame work. For optimal canopy design, apical growth should be inhibited within the first year of planting. Two to three months after planting, trees are topped to a consistent height of 60-70 cm from the ground level to encourage the appearance of new growth below the cut point, resulting in new shoots. Three to four equally spaced shoots are retained around the stem to form the main scaffold limbs of the tree. After topping, these shoots are left to develop for 4-5 months until they reach a length of roughly 40-50 cm. To include several shoots from the buds below the cut end, the selected shoots are further clipped to 50% of their original length. Newly developed branches are allowed to grow up to 40-50 cm before being clipped to allow new shoots to emerge. This is primarily done in order to achieve the required shape. The pruning operations continue during the second year after

planting. After two ye the short branches within the tree canopy produce a compact and strong structure after two years. All of the plants are pruned into a hedge shape with a 2 meter inter row width and 2.5 meter height every year in January-February and May-June. The short branches within the tree canopy produce a compact and strong structure. All the plants are confined to a hedge shape of 2 meter inter row width and 2.5 meter height for which pruning is performed in January- February and May-June every year.

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